2017 F=ma Exam: Problem 18

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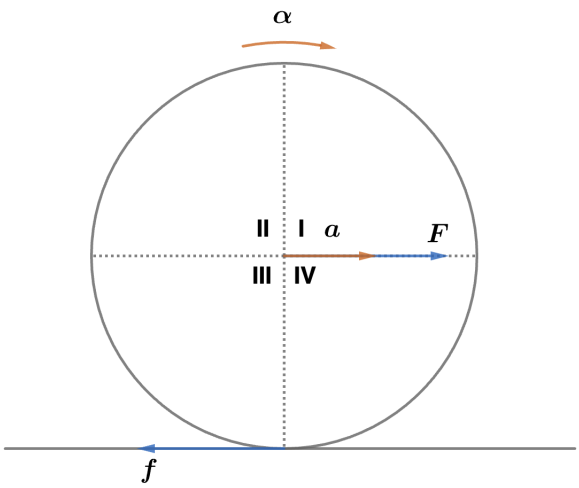
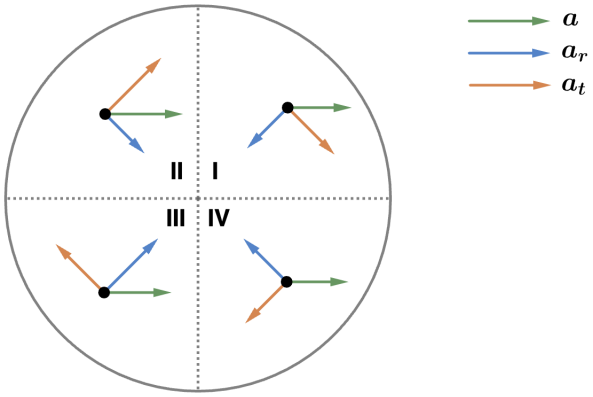
The disk is rolling without slipping with some translational acceleration a and angular acceleration α.



If we look at any point on the disk, the total acceleration of that point has contributions from a (through the translational acceleration a) and α (through the tangential acceleration $a_t = r\alpha$ and radial acceleration $a_r = \omega^2 r = (\alpha t)^2 r$).



In region I, the total acceleration always has a downward component. In region II, the total acceleration always has a rightward component. In region III, the total acceleration always has an upward component. In region IV, the different acceleration components could cancel out. Thus, the answer is $\boxed{\text{D}}$.